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Attorney Docket # 4925-193PUS

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Olli SALMELA et al.

Serial No.: 10/030,502

Filed: May 14, 2002

For: Method For Creating Waveguides in Multilayer Ceramic Structures and a Waveguide

Examiner: Lee, Benny T.
Group Art: 2817

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Teodor J. Holmberg
Name of applicant, assignee or Registered Representative

Signature

October 29, 2003
Date of Signature

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Mail Stop **Amendment**
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT

SIR:

Applicants hereby request a two month extension of the original shortened statutory response period set in the Office Action of June 17, 2003. A check in the amount of $420.00 in payment of the government fee for the two-month extension of time is enclosed herewith. Any additional fees or charges required at this time in connection with the present application may be charged to our Patent and Trademark Office Deposit Account No. 03-2412.

In response to the Office Action dated June 17, 2003, please amend the above-identified application as follows:

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims are reflected in the listing of claims which begins on page 5 of this paper.

Amendments to the Drawings begin on page 11 of this paper and include an attached replacement sheet.

Remarks/Arguments begin on page 12 of this paper.

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Amendments to the Specification:

Please delete the paragraph beginning at page 3, line 34, which starts with "Some preferred embodiments".

Please replace the paragraph beginning at page 4, line 20, with the following amended paragraph:

Figure 1 shows an [~~ordinary~~] prior art, air-filled waveguide made of conductive material,

Please delete the heading at page 5, before line 15, and rewrite the heading at follows:

-- **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS** --

Please replace the paragraph beginning at page 7, line 15, with the following amended paragraph:

Figure 4 shows an example of a structure according to the second embodiment of the invention as a section in the xy plane. The ceramic circuit structure is assembled by layers of ceramic plates/strips 41. The waveguide is separated from the rest of the structure in the direction of the x-axis by air-filled cavities 42 and 46 in the direction of the yz plane (not shown in FIG. 4), the width of which cavities is the measure L shown in the drawing and the height is the measure b shown in the drawing, and via posts 48 and 49 filled with conductive material. The core part 43 of the waveguide is formed by ceramic material, the permittivity ε_r of which is high compared to air. The width of the core part of the waveguide in the direction of the x-axis in denoted by the letter a in the drawing. The width L of the air-filled cavities 42 and 46 in the x-plane is selected such that its magnitude corresponds to a fourth of the wavelength of the cut-off frequency f_c. Then the waveguide structure emits as little interference radiation as possible to its environment. In the xz plane (not shown in FIG. 4), which is perpendicular to the surface shown in Fig. 4, the waveguide is limited by a first plane 44 and a second plane 45, which are essentially parallel and made of conductive material. The first plane 44 and the second plane 45 are connected to each other by vias 48 and 49, which are filled with conductive material. The waveforms TE_{mn} and TM_{mn} can propagate in a waveguide according to the embodiment shown

in the drawing. The cut-off frequencies f_{cmn} of these waveforms are obtained from the known formula:

$$f_{cm,n} = \frac{1}{2\sqrt{\mu\ \varepsilon}}\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$$

Please replace the paragraph beginning at page 9, line 21, with the following amended paragraph:

Figure 6a shows, by way of example, how the microstrip and the waveguide according to the invention can be joined together. The figure shows a section in the yz plane of the point where the conductors are connected. The circuit structure has been implemented by joining together several layers of ceramic plates 61a. The portion of the microstrip 60a is formed by the signal conductor 63a <u>(labeled "S" in FIG. 6a)</u> and the ground conductor 62a <u>(labeled "G" in FIG. 6a)</u>. The impedance of the transmission line changes at the point where the microstrip and the waveguide 68a are joined together. High impedance mismatches cause an undesired reflection of the signal back to its incoming direction in the above-mentioned interface. This reflection problem can be diminished by making at the joint a special structure, in which the impedance level of the transmission line is gradually changed. In the example of Fig. 6a, this matching of the impedances has been implemented by a so-called quarter-wave transformer 67a. It consists of steplike changes of the waveguide geometry of the length of $\lambda/4$ in the direction of the z-axis in the drawing. In Fig. 6a, it is accomplished by means of conductive plane surfaces 66a, which are connected to each other in the direction of the y-axis by vias 64a made of conductive material. In the direction of the x-axis, these planes 66a reach across the whole core part of the waveguide. <u>The second plane 65a forms the lower surface of the waveguide.</u> The electric properties of the ceramic material used in the structure are similar in all parts of the circuit structure in the example of the drawing.

Please replace the paragraph beginning at page 10, line 4, with the following amended paragraph:

Figure 6b shows an example of another way of joining a waveguide according to the invention to another electric circuit. The figure shows a section in the yz plane of the point where the transmission lines are connected. The circuit structure of the component has been implemented by joining together several layers of ceramic plates 61b. The exciting signal is brought to the waveguide by means of a cylindrical probe 63b. In the example of the drawing, the probe comes to the waveguide 68b through the first plane 62b, which forms the upper surface of the waveguide, and a hole 69b made in the plane. Thus the probe 63b does not have a galvanic connection to the conductive first plane 62b. The probe 63b itself may reach through several ceramic circuit structures in the direction of the y-axis of the drawing, when required. The impedance mismatch created at the feeding point of the signal is reduced by a quarter-wave transformer 67b of the kind described in connection with Figure 6a. The quarter-wave transformer 67b consists of conductive plane surfaces 66b, which are connected to each other in the direction of the y-axis of the drawing by vias 64b made of conductive material. In the direction of the x-axis of the drawing, these planes 66b reach across the whole core part of the waveguide. The second plane 65b forms the lower surface of the waveguide. The electric properties of the ceramic material used in the structure are similar in all parts of the circuit structure in the example of the drawing.